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Monitoring the Fermentation of cv. Kalamata Natural Black Olives Using Raman Spectroscopy

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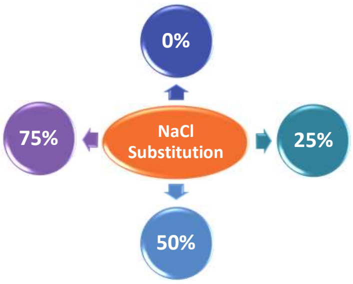
INTRODUCTION & AIM

Fermented olives hold considerable economic importance for the Mediterranean countries [1]. Kalamata natural black olives are renowned for their appealing organoleptic properties and nutritive value [2]. The aim of this study was to monitor the efficacy of Raman spectroscopy as a rapid and non-invasive technique to monitor the fermentation of cv. Kalamata olives under diverse substitution levels of NaCl by KCl in the brine.

METHOD

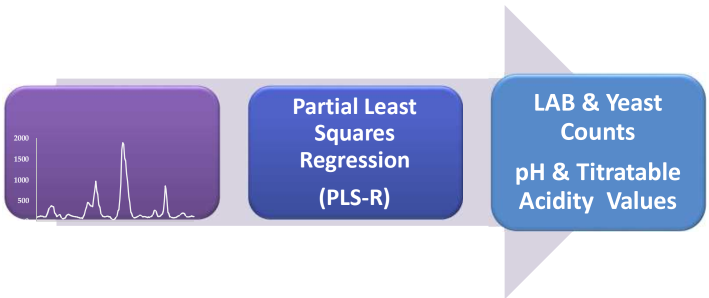
- ✓ Kalamata natural black olives were subjected to Greek-style processing according to the traditional anaerobic method in 7% brine.
- ✓ Partial substitutions of NaCl by KCl were performed.



- ✓ All fermentations were carried out in duplicate at 20-22°C for 145 days.

Raman Spectra Acquisition

- ✓ Raman spectra were acquired twice a week from the surface of fermenting olives.
- ✓ Spectra were averaged and the area from 1800 to 1000 cm^{-1} was included in the analysis.



RESULTS & DISCUSSION

The plot of scores (Figures 1 and 2), illustrate on the horizontal axis the class separation (i.e., NaCl vs. NaCl/KCl or beginning vs. end of fermentation, respectively), against the within class variation depicted in the vertical axis.

- ➢ The analysis reveals two distinct clusters for control fermentation against NaCl/KCl fermentations with some degree of overlapping (Figure 1).
- ➢ Distinct separation of classes was obtained along the horizontal axis between samples corresponding to the beginning and end of fermentation, with no overlapping at the 95% confidence interval level (Figure 2).

Figure 1. OPLS-DA Scores Plot Comparing Control (C) and NaCl substitution by KCl (S) in cv. Kalamata olive samples. Ellipses indicate the 95% confidence interval for each group.

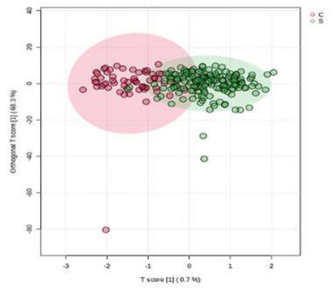


Figure 2. OPLS-DA Scores Plot comparing cv. Kalamata olives from all substitution levels at the beginning (S) and end (E) of fermentation. Ellipses indicate the 95% confidence interval for each group.

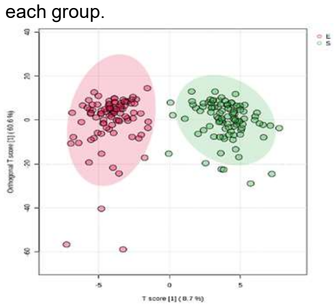


Table 1. Performance Metrics of Calibration and Cross-Validation for the PLS-R Models. The statistical outputs include Latent Variables (LVs), R^2 for Calibration (R^2_c), Cross-Validation (R^2_{cv}), and the Root Mean Squared Error (RMSE) of calibration and validation.

Model	LAB	LVs	R^2_C	$RMSE_C$	R^2_{CV}	$RMSE_{CV}$
LAB	SNV[1]	6	0.75	0.68	0.64	0.83
Yeasts	Raw data	5	0.51	0.52	0.44	0.58
pH	SNV[1]	5	0.72	0.33	0.65	0.38
Acidity	Raw data	6	0.73	0.089	0.56	0.11

[1] Standard Normal Variate

The best performance of PLS-R models is presented in Table 1 for each parameter measured. The results of validation are satisfactory but additional experiments are required to increase the robustness of models.

CONCLUSION

Overall, the results obtained in this work provided promising perspective for the utilization of Raman spectroscopy as a rapid and non-invasive technique to monitor table olive fermentation. However, substantial model validation through further studies are required.

FUTURE WORK / REFERENCES

1. Kazou, M.; Tzamourani, A.; Panagou, E.Z.; Tsakalidou, E. Unraveling the Microbiota of Natural Black Cv. Kalamata Fermented Olives through 16S and ITS Metataxonomic Analysis. Microorganisms 2020, 8, 672.
2. Rocha, J.; Borges, N.; Pinho, O. Table olives and health: a review. J. Nutr. Sci. 2020, 9, e57.